

Microbial Certification of the MER Spacecraft

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Spacecraft such as the Mars Exploration Rovers (MER) must meet acceptable microbial population levels prior to launch. Sensitive parts and materials prevent any single sterilization method from being used as a final step on the assembled spacecraft. Can a flight project achieve minimal microbial populations? Our approach to meeting the low population requirements include the active destruction of viable microbes and spores by Dry Heat Microbial Reduction (DHMR), the assembly of spacecraft in cleanrooms, frequent alcohol wiping of spacecraft parts, and use of protective barriers to prevent re-contamination. Procedural controls are used for evaluating and tracking components to ensure compliance with clean assembly practices and with the specifications of DHMR. Bioburden assessments utilize Tryptic Soy Agar (TSA) pour-plates and the enumeration of resulting colonies from aerobic spores. The use of a barcode system with a custom-designed database permits the tracking of colony counts from swab-samples, hardware parts and spacecraft zones, so that a running tally of the spacecraft bioburden is kept and statistical calculations can be carried out. Additional analytical methods that detect ATP and endotoxin (Limulus Amebocyte Lysate (LAL) assay) are performed for research purposes as rapid assessment methods. Pour-plate assay results, when compared to ATP and LAL results, lead to similar conclusions regarding the levels of cleanliness. For MER, the required bioburden level for surfaces is an average density of less than 300 spores/m² and a total bioburden of less than 3×10^5 spores. These levels apply to "exposed" (planetary protection accountable) surfaces only. Data from our bioassays of the spacecraft find the current estimates of the total spore population and spore density levels to be significantly less than these requirements. We conclude that a combination of DHMR and control measures during complex mechanical assembly processes can result in a total spore bioburden that meets requirements.